

Original Research Article

Diagnostic impact of emergency ultrasound for cholecystitis

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ABSTRACT

Background: Previous studies reported different rates of accuracy considering the use of POCUS in diagnosis of cholecystitis indicating that POCUS is not enough when deciding the management. The aim of this study is to compare POCUS findings in the diagnosing of the acute cholecystitis performed by both emergency medicine residents and radiologists.

Methods: A retrospective chart review was conducted in the ED of KAMC, Riyadh, Saudi Arabia. The population consisted of patients presented to the ER with RUQ (right upper quadrant pain) and had an abdominal ultrasound performed in the past 6 year. The study used BEST Care system to access the data of patients who underwent ultrasonography, since January 2016 using a data collection sheet.

Results: Our results included 1871 patients admitted in KAMC. Emergency physicians had success rate of 25% in correctly reporting the presence or absence of wall thickening, and 44.1% for pericholecystic fluid. In addition, scanning by emergency physicians has a success rate of 60% in detecting CBD dilatation, 12.7% for Murphy's sign, and 46.3% for acute cholecystitis. Moreover, we found that the presence of thickened gallbladder wall in the ultrasonographic finding is a significant predictor for cholecystitis as it is increasing its incidence by 2.09 times ($P=0.038$).

Conclusions: Ultrasonography conducted by emergency department could be useful in detecting characteristics of gallbladder however, in our study, it showed low accuracy in detecting gallstones and acute cholecystitis compared with surgical and pathological finding.

Keywords: Cholecystitis, Emergency, POCUS, Radiologist, RUQ

INTRODUCTION

Gallbladder and biliary tract disorders are one of the most common presenting cases of surgical disease in the emergency department (ED) which is responsible for 302,000 cases annually.¹ The Tokyo guidelines meta-analysis found that in patients under 50 years old complaining of abdominal pain there is a 6.3% incidence

of acute cholecystitis whereas patients above 50 years old were diagnosed 20.9% of the time.² When it comes to diagnostic imaging of probable acute cholecystitis, ultrasound is considered the most ideal option as it does not involve an invasive procedure nor harmful ionizing radiation to the patient. Point-of-care ultrasound (POCUS) can be performed by the assessing physician at the bedside during the initial patient evaluation, which

makes it even more ideal. Since POCUS is operator dependent, the sensitivity and specificity of it in diagnosing acute cholecystitis ranges greatly in the literature, as its sensitivity ranges from 68% to 90% and specificity from 71% to 100%.³⁻⁵

The diagnostic accuracy of using ultrasound in acute cholecystitis highly depends on the operator skills. The results of sensitivity and specificity rates showed a great variability in the studies that compared emergency physicians to radiologists. Sensitivity and specificity rates of emergency medicine specialists in the diagnosis of acute cholecystitis using POCUS have been reported to be 87%, and 82%, respectively. For radiologists, these rates have been 83% and 86%, respectively.⁶ Another study showed contradicting results with a sensitivity of 90% to 96% for ultrasounds performed by emergency physicians.^{4,7} The differences in diagnostic accuracy rates in the previous studies showed that relying on POCUS in cholecystitis is not enough when deciding the management plan for patients. The aim of this study was to compare POCUS findings in diagnosing acute cholecystitis performed by both emergency medicine residents and radiologists in KAMC, Riyadh region, Saudi Arabia.

METHODS

A retrospective chart review was conducted in the Emergency Department of King Abdulaziz Medical City, NGHHA, Riyadh, Saudi Arabia. The population consisted of patients who presented to the hospital with right upper quadrant pain (RUQ) and had an abdominal ultrasound performed in the past 6 years (2016-2022). Data about the Patients' medical history was collected using BEST Care, a system of electronic medical records. The data was viewed by the research group to exclusively ensure confidentiality. The study took place in King Abdulaziz Medical City, Riyadh, Saudi Arabia. It is the largest trauma center in the region with over 1500 beds tertiary care hospital that includes 150 bed ED that receives over 250,000 visits yearly from about 600,000 Saudi National Guards soldiers, their families, along with other employees.

Inclusion criteria

The inclusion criteria consist of all adult's patient, between the ages of 14 to 80 years old, of both genders, presenting to the ED with RUQ pain who underwent an abdominal ultrasound by both an emergency physician and a radiologist.

Inclusion criteria

The exclusion criteria include patients below 14 years and above 80 years of age, lack of documentation, incomplete information or those without comparative data as radiological finding or surgical finding.

Sample size

Total 1871 patients were eligible to our study as they underwent ultrasonography, upon presenting to the ED with RUQ, from January 2016 to January 2022 and matched our including and concluding criteria.

Data collection methods, instruments used, measurements

The study used BEST Care system to access the data of patients who underwent ultrasonography, since January 2016 using a data collection sheet. Dependent variables included age in years, gender. Independent variables included ultrasonographic findings including: >3mm thickness, sonographic Murphy's sign, gallstone, and pericholecystic fluid of the gallbladder detected by an emergency physician, a radiologist and/ or both.

Data management and analysis plan

Microsoft Excel was used for data entry. Data was filled into appropriately designed excel sheets. All data was entered on a data sheet then analyzed electronically on Statistical Package for Social Sciences (SPSS), coded, cleaned from missing data, and de-identified. Categorical variables were described as frequencies and percentages, and numerical variables as means and/or standard deviations. Chi-square test, independent t-test and ANOVA test were used as appropriate. A p-value of lower than 0.05 will be declared as significant.

RESULTS

In the current study, we could collect ultrasonographic finding of 1871 patients who admitted to the hospital of King Abdulaziz Medical city. Among these patients, 59.9% were females with an overall mean age of 46.84 - years-old (standard deviation of 16.8 years old) ranging between 14 and 80 years old. Ultrasonographic findings reported by emergency physicians were documented in 29.3% of the patients while radiologist reported nearly all of their scans, 99.9%, and we also collected 1044 finding of gallbladder surgery or pathology (Table 1).

The gallbladder was detected and presented in 88.1% of the ultrasonographic finding by emergency physicians while 96.1% in ultrasonographic finding by radiologist and in all samples collected by surgeries. Ultrasonographic finding of emergency physicians reported that 94.8% of gallstones presented were distended compared with 88.6% of those reported by radiologist. Moreover, gallbladder wall thickening was investigated in 195 cases by emergency physicians, 588 cases by radiologist and all sampled gallbladders by surgery. Among these cases, the incidence of wall thickening was 79%, 77.7%, and 92% in the finding of emergency physicians, radiologist, and surgery or pathological finding respectively. In addition,

pericholecystic fluid was reported in 35.2% of cases out of 165 patients investigated by emergency physicians while 62.8% out of 1053 patients assessed by radiologists reported pericholecystic fluid. Moreover, gallbladder stones were reported as positive in 82.0% (291/355) of finding of emergency physicians which showed that 63.3% of them were multiple stones while 90.3% of the radiological finding (1437/1591) reported stones where 99.8% of them were multiple stones and 91.8% of the pathological finding in which 72.1% were multiple

stones. Murphy’s sign was positive in 80.7% out of 88 patients were reported for Murphy’s sign by emergency physicians compared with 85.5% (224/262) of the radiological finding. The diagnosis of acute cholecystitis was reported in 125 patients by emergency physicians which represented 36.0% reported presence of acute cholecystitis while 50.8% of the radiological finding reported presence of acute cholecystitis (out of 606) (Table 2).

Table 1: Demographic factors of the patient.

		Count	Column N %
Gender	Male	750	40.1
	Female	1121	59.9
Age	Mean (SD)	46.84 (16.8)	
Ultrasonographic findings by Emergency physician	Conducted	548	29.3
	Not conducted	1323	70.7
Ultrasonographic findings by radiologist	Conducted	1869	99.9
	Not conducted	2	00.1
Findings of gall bladder Surgery or Pathology	Conducted	1044	55.8
	Not conducted	827	44.2

Table 2: Sonographic and pathological results as reported in emergency department and radiologist or after surgery.

		Ultrasonographic findings by emergency physician (%)	Ultrasonographic findings by radiologist (%)	Findings of gall bladder surgery or pathology (%)
Gallbladder present	Absent or not detected	65 (11.9)	73 (3.9)	0 (0.00)
	Present	483 (88.1)	1796 (96.1)	1044 (100.0)
Distension	Absence	4 (5.2)	103 (11.4)	0 (0.00)
	Presence	73 (94.8)	801 (88.6)	4 (100.0)
Wall thickening	Not thickened	41 (21.0)	131 (22.3)	64 (8.0)
	Thickened	154 (79.0)	457 (77.7)	734 (92.0)
Pericholecystic fluid	Absence	107 (64.8)	392 (37.2)	0.0 (0.00)
	Presence	58 (35.2)	661 (62.8)	0.0 (0.00)
Presence of gallbladder stones	Absence	64 (18.0)	154 (9.7)	84 (8.2)
	Presence	291 (82.0)	1437 (90.3)	945 (91.8)
Single/multiple (number)	Single	87 (36.7)	1 (0.2)	263 (27.9)
	Multiple	150 (63.3)	619 (99.8)	680 (72.1)
CBD dilatation	Not dilated	12 (34.3)	151 (28.2)	0 (0.0)
	Dilated	23 (65.7)	385 (71.8)	0 (0.0)
Murphy's sign	Negative	17 (19.3)	38 (14.5)	0 (0.0)
	Positive	71 (80.7)	224 (85.5)	0 (0.0)
Acute cholecystitis	Absent	80 (64.0)	298 (49.2 %)	0 (0.0)
	Present	45 (36.0)	308 (50.8)	30 (100.0)
Adenomyomas	Absent	0 (0.0)	1 (0.7)	0 (0.00%)
	Present	0 (0.0)	134 (99.3)	1 (100.0)
Neoplastic lesion	Absent	1 (50.0)	176 (100.0)	24 (77.4)
	Present	1 (50.0)	0 (0.0)	7 (22.6)

To assess the correctness of the ultrasonographic findings by Emergency physician, we compared its results with

surgical finding and when absent with radiological findings. Considering the detecting of gallbladder, we

found that emergency physicians reported the state of gallstones correctly in 87.5% of cases as compared with surgical finding and 86.4% as compared with radiological finding however, emergency finding reported inaccurately an absent gallbladder in 12.5% and 11.0% of cases as compared with surgical and radiological finding which inaccurately reported presence of gallbladder in 2.6% of cases as compared with radiological finding. The results showed significant difference between the finding of emergency physicians as compared with both radiological finding (P=0.000) and surgical finding (P=0.000). Moreover, the finding of distension of gallbladder was reported in 64.9% of cases when reported by radiologists where emergency physicians were able to accurately report the presence or absence of distention in 22.4% of cases. Considering wall thickening, our results showed that emergency physicians reported the presence or absence of wall thickening correctly in 25% of cases as compared with surgical finding while it has failure rate of

45.7% in detecting the thickening and 29.3% in reporting the presence of thickening. However, as compared with radiological finding, emergency physicians' success rate increased to 62.2%. Moreover, the accuracy rate of reported pericholecystic fluid by emergency physicians was 44.1% where the emergency physicians reported false absence of fluid in 47.5% of cases as compared with radiological finding. Considering the reporting of gallstones, emergency physicians had an accuracy of 53.6% and 60% as compared with surgical and radiological finding respectively. It was found that emergency physicians were not able to detect gallstones in 41.5% of patients who were confirmed cases with gallstones by pathology reports. In addition, scanning with emergency physicians has successful rate of 60% detecting CBD dilatation, 12.7% in detecting Murphy's signs, and 46.3% considering reporting cholecystitis (Table 3).

Table 3: The accuracy rates of ultrasonographic findings by emergency physicians as compared with radiological and surgical finding.

		As compared with radiology		P-value	As compared with surgical finding (%)		P-Value
		N	%		N	%	
Gallbladder presence	Correct present gallbladder	469	85.7	0.000*	272	87.5	0.000*
	Correct absent gallbladder	4	0.7		0	0.0	
	False absent gallbladder	60	11.0		39	12.5	
	False present gallbladder	14	2.6		0	0.0	
Distension	Correct positive distension	36	12.4	0.003	Not comparable		
	Correct negative distension	29	10.0				
	False negative distension	189	64.9				
	False positive distension	37	12.7				
Wall thickening	Correct present of wall thickening	40	7.3	1.000	66	22.0	0.007*
	Correct absent of wall thickening	301	54.9		9	3.0	
	False absent of thickening	93	17.0		137	45.7	
	False present of thickening	114	20.8		88	29.3	
Pericholecystic fluid	Correct positive report of fluid	26	6.9	0.000*	Not comparable		
	Correct negative report of fluid	141	37.2				
	False negative report of fluid	180	47.5				
	False positive report of fluid	32	8.4				
Presence of stones	Correct present of stones	245	44.7	0.000*	157	51.3	0.013*
	Correct absence of stones	84	15.3		7	2.3	
	False absence of stones	173	31.6		127	41.5	
	False positive stones	46	8.4		15	4.9	
Number of stones	False detecting of stones	18	9.7	0.000*	43	15.2	0.035*
	Correct single stone	40	21.6		13	4.6	
	Correct multiples stone	35	18.9		62	21.9	
	False single stone	92	49.7		147	51.9	
	False multiple stones	0	0.0		18	6.4	
CBD dilatation	Correct positive dilatation	5	50.0	0.343	Not comparable		
	Correct negative dilatation	1	10.0				
	False negative dilatation	3	30.0				
	False positive dilatation	1	10.0				
Murphy's sign	Correct positive murphy	15	11.9	0.001*	Not comparable		
	Correct negative murphy	1	0.8				

Continued.

		As compared with radiology		P-value	As compared with surgical finding (%)		P-Value
		N	%		N	%	
Acute cholecystitis	False negative murphy	54	42.9	0.210	Not comparable		
	False positive murphy	56	44.4				
	Correct positive cholecystitis	3	1.4				
	Correct negative cholecystitis	97	44.9				
	False positive cholecystitis	42	19.4				
	False negative cholecystitis	74	34.3				

Table 4: Ultrasonographic findings by emergency physicians as predictors for cholecystectomy.

		No cholecystectomy		Cholecystectomy		RR (CI 95 %)	P value
		N	%	N	%		
Distension	Absence	1	25.0	3	75.0	0.452 (0.04-4.55)	0.50
	Presence	31	42.5	42	57.5		
Wall thickening	Not thickened	24	58.5	17	41.5	Reference	0.038*
	Thickened	62	40.3	92	59.7	2.09 (1.04-4.21)	
Pericholecystic fluid	Absence	44	41.1	63	58.9	Reference	0.278
	Presence	29	50.0	29	50.0	0.69 (0.36-1.32)	
Presence of gallbladder stones	Absence	31	48.4	33	51.6	Reference	0.190
	Presence	115	39.5	176	60.5	1.44 (0.83-2.47)	
Single/multiple (number)	Single	31	35.6	56	64.4	Reference	0.287
	Multiple	64	42.7	86	57.3	0.74 (0.43-1.28)	
CBD dilatation	Not dilated	7	58.3	5	41.7	Reference	0.559
	Dilated	11	47.8	12	52.2	1.53 (0.37-6.25)	
Murphy's sign	Negative	6	35.3	9	64.7	Reference	0.719
	Positive	32	45.1	39	54.9	0.812 (0.26-2.52)	
Acute cholecystitis	Absent	38	47.5	42	52.5	Reference	0.742
	Present	20	44.4	25	55.6	1.31 (0.54-2.35)	

Moreover, we found that the presence of thickened gallbladder wall in the ultrasonographic finding is a significant predictor for performing cholecystectomy, increasing its incidence by 2.09 times (relative risk (RR): 2.09, 95% CI: 1.04-4.21, P=0.038). Moreover, the presence of gallbladder stones (RR=1.44, 95% CI: 0.83-2.47, P=0.190), single stone (RR=1.344, 95% CI: 0.77-2.31, P=0.287), CBD dilation (RR=1.53, 95% CI: 0.37-6.25, P=0.559) was related with slightly higher risk for conducting of cholecystectomy however, no significant difference was reported (Table 4).

DISCUSSION

Biliary disease is a major burden on the healthcare system in the United States and other countries with up to 20% of the population and more than 20 million people suffering from this disease.⁸ This leads to potentially life-threatening complications. Knowing that medical history and physical examination cannot reliably identify biliary tract disease, therefore, a quick but accurate screening is highly recommended. This is useful for several reasons which include identifying complications early and as well as possible in the emergency department, avoiding the

need for additional imaging which can reduce waiting time as well as improve patient outcomes through early identification of critical complications and early intervention. Our study is the first to report the effects of routine use of ultrasonography by emergency physicians in the care of patients with gallbladder disease. In this study, we have chosen the results of the pathological finding for comparison when available as the gold standard however, when pathological finding is not presented, radiological findings were used. This contrasts with conventional emergency physicians' ultrasonography validation studies that compare bedside test results to radiology department ultrasound. Finding on emergency physicians' ultrasonography scans in patients with highly suspected biliary disease would be used to predict the eventual need for surgery of gallbladder. Currently, surgeons are less likely to accept patients for cholecystectomy based on positive emergency physicians' ultrasonography studies alone, instead they are relying on confirmatory ultrasound examinations performed in the radiology department.^{9,12} A gap remains between this evidence and the decision to have surgery because of the potential distrust of biliary POCUS.⁹ The results of the current study showed that the

accuracy of reporting the state of gallbladder disease in emergency physicians' ultrasonography was 87.5% of cases as compared with surgical finding and 86.4% as compared with radiological finding. In addition, the accuracy rate of emergency physicians' ultrasonography considering the reporting of wall thickening, pericholecystic fluid, and gallstones was 25%, 44.1%, and 53.6%, respectively. Moreover, the positive predictive value for detecting stones was 91.2% while the negative predictive value was 5.2%. In a previous study, the presence of gallstones on the biliary point-of-care ultrasound in emergency department was the most significant feature predicting the eventual need for cholecystectomy.¹³ In a previous study, the authors showed that ultrasonography conducted by emergency physicians was successful in reporting the correct state of gallstone disease in 54.9% of cases with positive predictive value for detecting stones of 100% while the negative predictive value was 37.84%.¹⁴ In addition, the same study showed that ultrasonography conducted by emergency physicians was able to correctly reported the state of gallbladder's wall thickness in 74.5% of cases with positive predictive value for detecting gallbladder's wall thickness of 90.03% compared with 42.8% in our study while the negative predictive value was 50.0% compared with 6.16% in our study.¹⁴ Moreover, another study showed that emergency department ultrasound has an accuracy in detecting gallstones of 87.8% compared with radiological finding with positive predictive value for detecting stones of 91% while the negative predictive value was 83%.¹⁵ In addition, our results showed that the accuracy of reporting cholecystitis of 46.3%. This is lower than reported by some previous studies including the study of Summers S et al who reported that sensitivity and specificity of ultrasonography performed by emergency medicine specialist in detection of acute cholecystitis to be 83%, and 82%, as well as other studies which reported a sensitivity between 90-96% for detecting acute cholecystitis by ultrasonography conducted by emergency medicine specialist.^{4,6,7}

Moreover, another study showed that the sensitivity and specificity of ultrasonography in diagnosis of acute cholecystitis are 82% and 81% by evaluating 26 studies.¹⁶ In our study, only the presence of wall thickness was the significant predictor of performing cholecystectomy. In a previous study conducted by Villar et al, the authors showed that diagnosis based on evidence of stone in ultrasonography alone has excellent sensitivity and negative predictive value in diagnosis of acute cholecystitis, even more than when a combination of symptoms is used.¹⁷ In ultrasonography finding that conducted by emergency physicians, many information such as wall thickening, dilatation, and presence of gallstones were not reported which in addition to the importance of these specific results may represent a barrier to acceptance of biliary ultrasonography conducted by emergency physicians among surgeons and is an area to improve and should be brought to attention during training. Moreover, most of the finding of the

ultrasonography conducted by emergency physicians are not significant predictors for the need for cholecystectomy.

Our significant limitation shown in the study is the lack of documentation of emergency physicians after doing a POCUS to rule out gallbladder diseases as it affected the comparison between the two departments of emergency and radiology when diagnosing.

CONCLUSION

Ultrasonography conducted by emergency department could be useful in detecting some characteristics of gallbladder disease, however, in our study, it showed low accuracy in detecting gallstones and acute cholecystitis compared with surgical and pathological finding. More training among emergency physicians in dealing with ultrasonography and how to interrupt them should be considered to increase their sensitivity and accuracy.

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